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EFFECTS OF REVISING 4T HERRING CATCH-AT-AGE MATRICES ON THE 1989 ASSESSMENT

by

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Abstract

Catch and weight-at-age matrices for 4T herring were revised in three steps prior to the 1990 assessment; biological data files were edited, landings were updated, and methods for assigning spawning groups were standardized among years. The effects of each step on 1989 assessment conclusions were evaluated by comparing population estimates and fishing mortalities at each step. The greatest effects on population estimates and fishing mortalities occurred at the first step of the revision process. Depending on target F, fully recruited F=0.3 or weighted F 5+=0.3, revising the catch and weight-at-age matrices resulted in a 10-13,000 t difference in 1990 projections or a 27% increase from the 1989 forecasts.

RÉSUMÉ

Avant d'effectuer l'évaluation de 1990, on a procédé à une révision en trois étapes des matrices des prises et des poids selon l'âge applicables au hareng de la division 4T. En premier lieu, on a purgé les fichiers de données biologiques, puis on a mis à jour les débarquements et, enfin, on a normalisé les méthodes utilisées au fil des ans pour cerner les groupes de reproducteurs. On a ensuite étudié les effets de chacune de ces modifications sur les conclusions de l'évaluation de 1989, en comparant les estimations de population et les mortalités dues à la pêche dans chacun des cas. C'est à la première étape du processus de révision que ces effets ont été les plus marquants. Selon la valeur F ciblée, une valeur F = 0,3 à plein recrutement ou une valeur pondérée F 5+ = 0.3, la révision des matrices des prises et des poids selon l'âge s'est traduit par un écart de 10 000 à 13 000 t par rapport aux projections de 1990 ou à un accroissement de 27 p. 100 par rapport aux prévision de 1989.

Introduction

Catch and weight-at-age matrices for 4T herring were revised for the 1990 assessment to address the concerns outlined in Dupuis and MacDougall (1990). There were three steps in the revision process, first, detailed sampling and length-frequency data files were edited and corrected. Second, landings for area, gear-type, and season cells were updated. Third, spawning group assignment was standardized so that spring and fall spawners were assigned by the same methodology in each year (gonad development where definitive and otolith morphology for all other cases) (Dupuis and MacDougall 1990). As a result, all years in the catch and weight-at-age matrices were affected.

After all revisions were completed the greatest changes in the catch-at-age matrices were at the extreme ages which were a minor component of the catch. However, the effects of each step on estimates of stock size and fishing mortality, and the effect of final revisions on projections were not evaluated (Dupuis and MacDougall 1990). This paper reports on the effects each sequential step in the catch and weight-at-age revision process had on the 1989 4T herring assessment (Chadwick et al. 1989).

Materials and Methods

Catch and weight-at-age matrices by spawning group (Appendix 1) were calculated for each step in the revision process for all gears and for fixed and mobile gears separately as described by Dupuis and MacDougall (1990). In this paper, the term matrix when used alone refers to both catch and weight-at-age matrices, any deviation from this convention will be to define precisely which of these two matrices is meant. In this paper PREVIOUS refers to matrices used in the 1989 assessment (Chadwick et al. 1989), EDITED refers to changes in the matrices resulting from editing and correcting detailed and length frequency data files, UPDATED refers to changes in the matrices resulting from incorporating the EDITED step and updated landings, and REVISED refers to final matrix revisions made by standardizing spawning group assignment after EDITED and UPDATED steps.

Matrices used in previous assessments did not include years prior to 1978. As a result, the years 1974-1977 were not included in the matrices until the landings were updated and could be partitioned into appropriate area, season, and gear-type cells. UPDATED files generally involved adding landings to each cell but landings went down in some cells because of changes in allocating unknowns or mistakes in data files.

The effects of each step on assessment conclusions were evaluated by comparing ratios of catch-at-age matrices from each step to the preceeding step and by comparing population numbers and fishing mortalities from ADAPT runs at each step.

Projections comparable to those made in the 1989 assessment (Chadwick et al. 1989) were made using population numbers and partial recruitments derived from the ADAPT run using REVISED matrices and catch and weight-at-age for 1988 from the REVISED matrices. Population numbers at age 2 were geometric mean numbers (1978 to 1986). Numbers at age 3 were age 2 numbers adjusted for natural mortality. Only natural mortality needed to be considered in deriving age 3 population numbers because age 2 fishing mortality is very low and approaches zero (Table 2). Partial recruitment (PR) was calculated as the mean for recent years, 1986-1988, using a two-way ANOVA with age and year effects on fishing mortalities. Ages 9 and 10 were removed from the model because Fs for these years depend on input to the model. Only recent years were used because trends in years previous to 1985 differed from those between 1986 and 1988. Input parameters for previous projections can be found in Chadwick et al. 1989; input parameters for projections based on REVISED matrices are provided below:

Fall Spawners

Age	Population Numbers x1000	Catch x1000	Weight (kg)	PR
2	389787	3984	0.0934	0.001
3	319625	3714	0.1981	0.07
4	265475	23612	0.2608	0.37
5	326599	43538	0.2909	0.50
6	183676	24846	0.3244	0.65
7	97039	22950	0.3404	0.97
8	103286	20477	0.3676	1
9	42596	11800	0.3925	1
10+	26119	7392	0.4129	1

Before evaluating matrix revision effects on the 1989 assessment, a change was made in one of the input parameters for the ADAPT run used in that assessment. The abundance index was revised so that age 10+ fish weights were based on a mean weight-at-age weighted by catch for age 10 and 11 herring, rather than weight-at-age for age 10 herring as was done in 1989 (Chadwick et al. 1989). The ADAPT input summary is provided in Table 1.

Results and Discussion

Revising the abundance index had little effect on the 1989 assessment results. Parameter estimates were significant and similar to those in the 1989 assessment (Table 2). Population number and fishing mortalities were also similar (Table 3).

The greatest differences in catchability, population numbers, and fishing mortality estimates made in the 1989 assessment and those made using the EDITED, UPDATED, and REVISED matrices were the result of the first step in the revision process, editing the biological and length-frequency files (Tables 2b, 3b and 4-11). Impacts of these changes were that population numbers generally increased (Tables 3b and 5) and that fishing mortality except for 1985, was lower than previously calculated (Tables 3b and 6). In addition, partial recruitments for the last year indicate that 4T herring were fully recruited at age 7 rather than age 9 (Table 7).

Generally, full recruitment is interpreted as a partial recruitment equal to one, as was the case for the 1989 assessment when partial recruitment increased steadily to age 9 and then declined slightly at age 10 (line R, Table 7). However, the partial recruitment pattern observed using the REVISED matrices differed considerably from the 1989 assessment. Partial recruitment increased steadily to age 7, declined at age 8, and increased for ages 9 and 10 (lines A, B, C, Table 7). This pattern could be a result of first, including all fish older than age 10 in the 10+ age-class and second, of the ADAPT formulation used, fishing mortality is equal for ages 9 and 10+. The fishing mortality for age 10+ will be higher than expected for age 10 fish because more than one age is included in this age-class, as a result, the age 10+ fishing mortality includes the sum of fishing mortaltites over more than one age. The assumption that age 9 and age 10+ fishing mortalities are equal means that age 9 and age 10+ fishing mortalities are not independent. This dependency must be considered when interpreting patterns of partial recruitment. Age 8 partial recruitments were below age 7 and ages 9 and 10+ partial recruitments. Hence, we conclude that partial recruitments for ages 9 and 10+ were over-estimated and that fish were fully recruited at age 7 (Table 7). Assumptions pertaining to partial recruitments have been a problem in the past for all Atlantic herring assessments and will be the subject of future research.

Depending on target F, fully recruited F=0.3 or weighted F 5+=0.3, revising the catch-at-age matrices resulted in a 10-13,000 t difference in 1990 projections (Table 8).

The best fit to the model occurred using the UPDATED matrices (Table 4). The only difference between UPDATED and REVISED matrices was in 1985 and 1986. For these years in the UPDATED matrices, if gonad maturity was not definitive, spawning group assignments were done using otolith characteristics based on a discriminant analysis rather than the ager's determination as was done in the REVISED matrices.

Most landings had previously been accounted for and because the method for assigning spawning group changed for only two years it was not surprising that the greatest change in 1989 assessment results occurred because of editing the detailed sampling and length-frequency files. Sampling and length-frequency files are used to determine age-length keys and average weights and any changes in these parameters will be magnified when they are applied to the landings to determine catch and weight-at-age. As a result, their effect on the final matrices may be expected to be greater than those associated with small changes in landings.

References

Chadwick, E. M. P., D. K. Cairns and H. M. Dupuis. 1989. Assessment of Atlantic herring in NAFO Division 4T, 1988. CAFSAC Res. Doc. 89/63 60 p.

Dupuis, H. M. C. and C. J. MacDougall. 1990. Revisions to the 4T herring catch-at-age matrices. CAFSAC Res. Doc. 90/15 19p.

Table 1. ADAPT input summary for Div. 4T herring.

Parameters:

- year-class estimates: $N_{i,1988}$ i=4-10+
- calibration constants for gillnet catch rates population at age: K_i i=4-10+

Structure:

- F for oldest age group (10+) assumed to equal F at age 9 (CALC-F)
- model did not include an intercept term

Input:

- $Catch_{i,t}$ i=4-10+; t=1978-1988
- $CPUE_{i,t}$ (catch/net/trip) i=4-10+; t=1978-1988
- M=0.2

Objective Function:

- log transformation
- minimize $(\ln (CPUE_{i,t}) - \ln (q_i N_{i,t}))^2$

Summary:

- number of observations = 99
- number of parameters = 14

Table 2. Parameter estimates and correlation matrices from 4T herring ADAPT runs from A) 1989 assessment and B) re-run of 1989 assessment with weighted 10+ abundance index.

A) ESTIMATED PARAMETERS AND STANDARD ERRORS
APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET..... 0.000000
MEAN SQUARE RESIDUALS..... 0.151602

NO.	AGE	PAR. EST.	STD. ERR.	T-STATISTIC
Population Numbers				
1	4	2.29236E0005	8.21976E0004	2.78884E000
2	5	2.86161E0005	7.39080E0004	3.87185E000
3	6	1.47348E0005	3.40953E0004	4.32165E000
4	7	8.34087E0004	1.77564E0004	4.69739E000
5	8	7.67804E0004	1.64363E0004	4.67140E000
6	9	3.31908E0004	6.72426E0004	4.93597E000
7	10+	1.79610E0004	3.65735E0004	4.91095E000
Catchability (q)				
8	4	1.29994E-003	1.72399E-004	7.54032E000
9	5	1.88391E-003	2.43858E-004	7.72542E000
10	6	2.21505E-003	2.84927E-004	7.77410E000
11	7	2.63368E-003	3.41141E-004	7.72021E000
12	8	3.66543E-003	4.82309E-004	7.59976E000
13	9	3.40311E-003	4.66661E-004	7.29247E000
14	10+	3.84752E-003	5.59771E-004	6.87337E000

Parameter Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.0	.08	.06	.05	.05	.04	.06	-.32	-.05	-.04	-.03	-.03	-.03	-.03
2		1.0	.10	.08	.07	.06	.09	-.24	-.27	-.06	-.05	-.-5	-.05	-.05
3			1.0	.10	.09	.08	.12	-.20	-.22	-.25	-.07	-.06	-.07	-.07
4				1.0	.11	.09	.15	-.17	-.19	.22	-.26	-.08	-.08	-.09
5					1.0	.12	.19	-.14	-.16	-.18	-.23	-.27	-.10	-.11
6						1.0	.24	-.13	-.14	-.16	-.18	-.24	-.30	-.14
7							1.0	-.18	-.21	-.26	-.30	-.37	-.47	-.59
8								1.0	.15	.12	.11	.10	.10	.10
9									1.0	.14	.12	.11	.12	.12
10										1.0	.14	.13	.14	.15
11											1.0	.16	.17	.18
12												1.0	.20	.21
13													1.0	.28
14														1.0

Table 2 (continued)

B) APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET..... 0.000264
MEAN SQUARE RESIDUALS..... 0.154401

NO.	AGE	PAR.EST	STD. ERR.	T-STATISTIC
Population Numbers				
1	4	2.27702E0005	8.23032E0004	2.76662E000
2	5	2.84826E0005	7.41643E0004	3.84047E000
3	6	1.46322E0005	3.41346E0004	4.28663E000
4	7	8.26578E0004	1.77327E0004	4.66132E000
5	8	7.50524E0004	1.61728E0004	4.64065E000
6	9	3.18977E0004	6.46859E0003	4.93118E000
7	10+	1.76065E0004	3.60928E0003	4.87811E000
Catchability (q)				
8	4	1.30886E-003	1.74961E-004	7.48088E000
9	5	1.89183E-003	2.46783E-004	7.66596E000
10	6	2.23788E-003	2.90021E-004	7.71625E000
11	7	2.66539E-003	3.47772E-004	7.66419E000
12	8	3.83302E-003	5.08027E-004	7.54492E000
13	9	3.68416E-003	5.09046E-004	7.23737E000
14	10+	3.66756E-003	5.37617E-004	6.82188E000

Parameter Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.0	.08	.06	.05	.05	.04	.06	-.32	-.05	-.04	-.03	-.03	-.03	-.03
2		1.0	.09	.08	.07	.06	.09	-.23	-.27	-.06	-.05	-.05	-.05	-.05
3			1.0	.10	.08	.07	.11	-.20	-.22	-.25	-.07	-.06	-.06	-.07
4				1.0	.11	.09	.15	-.16	-.18	-.21	-.26	-.08	-.08	-.09
5					1.0	.12	.18	-.14	-.15	-.17	-.22	-.27	-.10	-.11
6						1.0	.23	-.12	-.14	-.15	-.18	-.23	-.30	-.14
7							1.0	-.17	-.21	-.25	-.30	-.36	-.47	-.58
8								1.0	.15	.12	.10	.10	.10	.10
9									1.0	.13	.12	.11	.12	.12
10										1.0	.14	.13	.14	.15
11											1.0	.16	.16	.17
12												1.0	.20	.21
13													1.0	.27
14														1.0

Table 3. Population numbers ('000s) and fishing mortalities for 4T herring estimated using ADAPT for A) 1989 assessment and B) re-run of 1989 assessment using weighted 10+ abundance index.

A) FALL SPAWNERS POPULATION NUMBERS

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	87528	285197	260836	379438	564481	372400	457307	589870	353617	43022	36428
3	131770	70292	230870	212316	310559	461991	304864	374403	482918	289218	35172
4	90868	90378	51925	159677	164714	245874	373920	248575	303155	391424	228320
5	43267	49624	42298	33468	100689	115378	179698	281239	187505	215694	284610
6	9325	22673	15629	13568	21999	58778	84537	132422	208478	129751	146571
7	10105	4040	8511	5247	8750	12887	35779	57475	96995	138987	82864
8	24721	5138	1205	3232	3411	5043	8371	23214	41811	61245	76263
9	3433	7705	1377	411	1762	1884	2440	5600	17066	25054	32909
10+	36660	16299	5334	1862	808	1279	1667	2650	6201	15077	17616
5+	127512	105479	74354	57787	137418	195250	312491	502601	558056	585808	641033

FISHING MORTALITY

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	.02	.01	.01	.00	.00	.00	.00	.00	.00	.00	.00
3	.18	.10	.17	.05	.03	.01	.00	.01	.01	.04	.05
4	.41	.56	.24	.26	.16	.11	.09	.08	.14	.12	.14
5	.45	.96	.94	.22	.34	.11	.11	.10	.17	.19	.23
6	.64	.78	.89	.24	.34	.30	.19	.11	.21	.25	.22
7	.48	1.01	.77	.23	.35	.23	.23	.12	.26	.40	.29
8	.97	1.12	.88	.41	.39	.53	.20	.11	.31	.42	.31
9	.71	1.33	1.10	.85	.51	.45	.24	.09	.24	.62	.41
10+	.71	1.33	1.10	.85	.51	.45	.24	.09	.24	.62	.39

Table 3 (continued)

B) FALL SPAWNERS POPULATION NUMBERS

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	87350	284606	259738	374195	558748	370361	455027	587440	351333	39916	36428
3	131720	70146	230386	211417	306266	457298	303194	372536	480928	287347	32629
4	90848	90337	51805	159281	163977	242359	370077	247208	301626	389795	226789
5	43258	49607	42264	33371	100364	114776	176820	278093	186386	214443	283277
6	9324	22665	15615	13540	21919	58512	84043	130066	205902	128835	145547
7	10105	4039	8505	5236	8728	12822	35561	57071	95066	136878	82113
8	24720	5138	1205	3226	3402	5025	8318	23036	41480	59666	74537
9	3433	7705	1376	410	1757	1877	2425	5556	16921	24783	31616
10+	36659	16297	5333	1861	806	1274	1657	2630	6148	14914	17462
5+	127498	105451	74298	57643	136976	194285	308824	496453	551903	579519	634551

FISHING MORTALITY

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	.02	.01	.01	.00	.00	.00	.00	.00	.00	.00	.00
3	.18	.10	.17	.05	.03	.01	.00	.01	.01	.04	.05
4	.41	.56	.24	.26	.16	.12	.09	.08	.14	.12	.14
5	.45	.96	.94	.22	.34	.11	.11	.10	.17	.19	.23
6	.64	.78	.89	.29	.34	.30	.19	.11	.21	.25	.22
7	.48	1.01	.77	.28	.35	.23	.23	.12	.27	.41	.30
8	.97	1.12	.88	.41	.40	.53	.20	.11	.32	.44	.32
9	.71	1.33	1.10	.85	.51	.45	.25	.09	.24	.63	.44
10+	.71	1.33	1.10	.85	.51	.45	.25	.09	.24	.63	.40

Table 4. Parameter estimates and correlation matrix from 4T herring ADAPT runs with A) EDITED, B) UPDATED, and C) REVISED catch-at-age matrices.

A) ORHTOGONALITY OFFSET..... 0.005954
MEAN SQUARE RESIDUALS..... 0.160386

No.	Age	PAR. EST.	STD. ERR.	T-STATISTIC
Population Numbers				
1	4	2.54754E0005	9.72564E0004	2.61940E000
2	5	2.96565E0005	8.15040E0004	3.63866E000
3	6	1.67696E0005	4.07095E0004	4.11933E000
4	7	8.91133E0004	1.91826E0004	4.64552E000
5	8	1.00968E0005	2.24024E0004	4.50702E000
6	9	4.15814E0004	8.74663E0003	4.75399E000
7	10+	2.22808E0004	4.59586E0003	4.84802E000
Catchability (q)				
8	4	1.13044E-003	1.56443E-004	7.22589E000
9	5	1.78350E-003	2.41160E-004	7.39551E000
10	6	1.83528E-003	2.47255E-004	7.42263E000
11	7	2.25771E-003	3.08998E-004	7.32079E000
12	8	2.82079E-003	3.91589E-004	7.20344E000
13	9	2.84213E-003	4.12131E-004	6.89617E000
14	10+	2.96525E-003	4.59694E-004	6.45048E000

B) ORTHOGONALITY OFFSET..... 0.000000
MEAN SQUARE RESIDUALS..... 0.120937

No.	Age	PAR. EST.	STD. ERR.	T-STATISTIC
Population Numbers				
1	4	2.56218E0005	8.49312E0004	3.01677E000
2	5	3.02702E0005	7.23198E0004	4.18561E000
3	6	1.69179E0005	3.55961E0004	4.75274E000
4	7	8.69468E0004	1.61144E0004	5.39559E000
5	8	9.65730E0004	1.84855E0004	5.22425E000
6	9	4.01448E0004	7.25446E0003	5.53381E000
7	10+	2.26807E0004	3.98364E0003	5.69345E000
Catchability (q)				
8	4	1.11846E-003	1.34076E-004	8.34194E000
9	5	1.72254E-003	2.01263E-004	8.55868E000
10	6	1.86963E-003	2.17210E-004	8.60749E000
11	7	2.38835E-003	2.80917E-004	8.50197E000
12	8	3.16309E-003	3.77483E-004	8.37943E000
13	9	2.93138E-003	3.64759E-004	8.03649E000
14	10+	3.15124E-003	4.17744E-004	7.54348E000

Table 4 (continued)

C) ORTHOGONALITY OFFSET..... 0.000259
MEAN SQUARE RESIDUALS..... 0.145782

No.	Age	PAR. EST.	STD. ERR.	T-STATISTIC
Population Numbers				
1	4	2.66375E0005	9.74583E0004	2.73322E000
2	5	3.28008E0005	8.69530E0004	3.77224E000
3	6	1.84476E0005	4.29411E0004	4.29603E000
4	7	8.76677E0004	2.01993E0004	4.83620E000
5	8	1.03882E0005	2.21106E0004	4.69826E000
6	9	4.28237E0004	8.68492E0003	4.94233E000
7	10+	2.63244E0004	5.36980E0003	4.90276E000
Catchability (q)				
8	4	1.07110E-003	1.42220E-004	7.53132E000
9	5	1.51442E-003	1.96255E-004	7.71658E000
10	6	1.64443E-003	2.12383E-004	7.74276E000
11	7	2.15410E-003	2.82499E-004	7.62517E000
12	8	2.88529E-003	3.86744E-004	7.46047E000
13	9	2.55437E-003	3.58784E-004	7.11953E000
14	10+	2.45210E-003	3.66546E-004	6.68973E000

Table 5. Fall spawner population numbers ('000s) for 4T herring determined using A) EDITED, B) UPDATED, and C) REVISED catch-at-age matrices.

A) FALL SPAWNERS POPULATION NUMBERS

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	101648	309450	247627	407105	642646	369759	499989	606724	391708	95092	4397796
3	136928	82212	250142	199632	332901	525971	302614	409319	496677	320580	77796
4	81205	97221	60429	161833	152793	265442	426463	246707	333841	403449	253875
5	43613	46214	45754	32517	101790	109533	195059	325888	196032	240498	295205
6	12590	23731	15529	16351	18583	63232	80094	146246	248883	135986	166925
7	14107	6564	8875	6134	10740	10866	39123	57464	111922	168042	88475
8	27045	6884	2846	2440	3816	6926	7051	26057	44099	72146	100380
9	2949	6617	2902	869	1333	2304	4187	4338	20167	28295	41257
10+	29186	9611	2698	1373	1271	1422	2325	4628	6749	17625	22079

B) FALL SPAWNERS POPULATION NUMBERS

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	101510	292127	249286	404228	630519	359761	502325	617837	393875	95194	4397796
3	148409	61741	236688	201959	330630	516042	294357	411236	505715	322338	77882
4	92334	100656	60581	157701	156205	263815	416301	239979	334301	411356	255335
5	45983	48656	47180	33064	101920	111219	191919	317171	189915	242240	301329
6	13424	23930	16308	17022	20307	64337	80963	144068	239886	133270	168401
7	14860	6763	8425	6380	10991	11661	39803	58241	109636	162595	86307
8	30862	7233	2468	2692	3790	6553	7600	26683	44486	70346	95985
9	3449	7855	2869	680	1406	2091	3779	4785	20566	28569	39818
10+	35986	13699	2593	1584	1160	1309	1998	4003	6428	17797	22476

C) FALL SPAWNERS POPULATION NUMBERS

Age	1978	1979	1980	1981	9812	1983	1984	1985	1986	1987	1988
2	101120	306963	282788	425147	678902	397564	589818	663895	409448	95194	4397796
3	155750	81422	248835	229389	347757	555654	325303	441933	542903	334724	77682
4	94719	106667	60320	167645	178662	277637	448733	265320	357885	442220	265475
5	46800	50608	52101	32850	110063	129606	203400	343724	201930	260897	326599
6	13627	24600	17907	21051	20132	71003	96017	153467	254099	146379	183676
7	15510	6929	9973	7689	14290	11517	45261	70566	113377	171512	97039
8	30948	7438	2604	3141	4861	8254	7462	31152	50366	73739	103286
9	3462	7926	3037	791	1773	2968	5990	4688	22553	31313	42596
10+	36124	13823	2745	1643	1463	1353	3167	6775	7614	19506	26119

Table 6. Fishing mortalities for 4T herring determined using A) EDITED, B) UPDATED, and C) REVISED catch-at-age matrices.

A) FISHING MORTALITY

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	.01	.01	.02	.00	.00	.00	.00	.00	.00	.00	.00
3	.14	.11	.24	.07	.03	.01	.00	.00	.01	.03	.05
4	.36	.55	.42	.26	.13	.11	.07	.03	.13	.11	.11
5	.41	.89	.83	.36	.28	.11	.09	.07	.17	.17	.18
6	.45	.78	.73	.22	.34	.28	.13	.07	.19	.23	.18
7	.52	.64	1.09	.28	.24	.23	.21	.07	.24	.32	.33
8	1.21	.66	.99	.41	.30	.30	.29	.06	.24	.36	.25
9	1.03	1.62	1.23	.38	.41	.28	.15	.09	.23	.54	.37
10+	1.03	1.62	1.23	.38	.41	.28	.15	.09	.23	.54	.45

B) FISHING MORTALITY

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	.02	.01	.01	.00	.00	.00	.00	.00	.00	.00	.00
3	.19	.10	.21	.06	.03	.02	.00	.01	.01	.03	.05
4	.44	.56	.41	.24	.14	.12	.07	.03	.12	.11	.11
5	.45	.89	.82	.29	.26	.12	.09	.08	.15	.16	.17
6	.49	.84	.74	.24	.36	.28	.13	.07	.19	.23	.18
7	.52	.81	.94	.32	.32	.23	.20	.07	.24	.33	.35
8	1.17	.73	1.09	.45	.40	.35	.26	.06	.24	.37	.27
9	.87	1.95	1.06	.48	.48	.34	.17	.12	.22	.54	.39
10+	.87	1.95	1.06	.48	.48	.34	.17	.12	.22	.54	.45

C) FISHING MORTALITY

Age	1978	1979	1980	1981	1982	1983	1984	1985	1985	1987	1988
2	.02	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00
3	.18	.10	.20	.05	.02	.01	.00	.01	.00	.03	.05
4	.43	.52	.41	.22	.12	.11	.07	.07	.12	.10	.10
5	.44	.84	.71	.29	.24	.10	.08	.10	.12	.15	.16
6	.48	.81	.65	.19	.36	.25	.11	.10	.19	.21	.16
7	.51	.78	.85	.26	.24	.23	.17	.14	.23	.31	.30
8	1.16	.70	.99	.37	.29	.24	.27	.14	.28	.35	.25
9	.87	1.90	.96	.40	.36	.23	.11	.21	.23	.48	.36
10+	.87	1.90	.96	.40	.36	.23	.11	.21	.23	.48	.37

Table 7. Partial recruitments for 4T herring determined using R) re-run from 1989 assessment with 10+ weighted abundance index, A) EDITED, B) UPDATED, and C) REVISED catch-at-age matrices.

	Age								
Matrix	2	3	4	5	6	7	8	9	10+
R	.00	.12	.33	.52	.50	.68	.72	1.00	.91
A	.00	.12	.24	.39	.39	.74	.56	.83	1.00
B	.00	.12	.24	.39	.40	.77	.60	.88	1.00
C	.00	.15	.28	.43	.43	.81	.66	.98	1.00

Table 8. Comparison of 4T herring projections in previous assessment based on the 1989 catch.

	1989 catch			
	Fully Recruited F=0.3		Weighted F 5+=0.3	
Previous matrices	1989	1990	1989	1990
Catch (t)	45,500	38,200	55,500	49,300
5+ Biomass (t)	148,500	134,500	148,500	129,900
Fully recruited F	0.34	0.30	0.34	0.40
Recruitment('000s)	344,411	344,411	344,411	344,411
Revised matrices				
Catch (t)	45,500	48,700	45,500	62,700
5+ Biomass (t)	191,200	175,100	191,200	168,900
Fully recruited F	0.27	0.30	0.27	0.40
Recruitment('000s)	389,787	389,787	389,787	389,787

Table 9. EDITED:PREVIOUS ratios for 4T herring catch-at-age matrices.

SPRING SPAWNERS - ALL GEARS

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	.850	.930	.432	.210	.835	1.540	1.440	6.080	4.721	1.346	13.075
3	.780	1.130	.502	.517	.683	1.955	1.675	1.169	1.280	1.142	.898
4	.693	1.820	1.511	.765	.733	.864	1.562	2.493	1.070	1.099	.592
5	.678	1.152	1.935	1.356	.602	.554	.740	1.852	1.019	1.026	.696
6	.731	2.954	1.170	1.935	1.119	.453	.524	2.012	.956	0.945	.874
7	1.116	1.508	2.336	.862	1.290	1.057	.871	2.607	.922	0.928	1.099
8	.951	2.686	1.747	1.135	.882	.960	5.273	5.404	2.041	1.027	.889
9	1.366	3.202	3.199	.763	.886	.647	1.818	2.369	.734	1.005	1.163
10	1.246	.993	3.359	3.306	41.000	.000	.182	.000	1.359	1.046	.419
11+	1.296	.728	.398	.552	3.864	.000	.000	.000	.722	0.969	1.187

FALL SPAWNERS - ALL GEARS

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	.738	1.223	2.509	4.138	1.103	3.771	4.556	2.467	.411	1.105	120.727
3	.850	1.223	1.464	1.168	.848	.963	1.025	.379	.681	1.015	2.384
4	.818	1.068	1.875	1.022	.799	1.031	.935	.372	1.010	.991	.866
5	.939	.892	1.002	1.488	.850	.965	.915	.823	1.031	.998	.825
6	1.042	1.050	.872	1.123	.849	1.024	.691	.684	1.127	.978	.943
7	1.488	1.203	1.292	1.363	.880	.847	.983	.562	1.073	.991	1.185
8	1.239	.966	2.535	.752	.902	.878	1.144	.602	.851	1.033	1.107
9	1.085	.942	2.236	1.148	.643	.817	1.073	.763	1.135	1.018	1.147
10	2.282	1.506	4.294	1.787	1.538	1.184	1.351	1.729	1.026	1.021	1.413
11+	.936	.589	.131	.228	1.173	.579	.448	.000	1.060	1.140	1.374

Table 10. UPDATED:EDITED ratios for 4T herring catch-at-age matrices.

SPRING SPAWNERS - ALL GEARS

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	1.350	.775	1.399	.977	1.400	1.000	1.000	1.908	.969	1.000	1.001
2	1.348	.785	1.339	1.297	1.000	.467	.795	1.861	1.006	.836	.995
3	1.222	.934	1.140	1.371	1.071	.773	.922	1.130	1.007	.904	1.359
4	1.158	1.018	1.331	1.288	.955	.993	.964	1.080	1.022	1.011	1.246
5	1.175	.950	1.161	1.156	1.196	.925	.965	1.112	1.027	.991	1.135
6	1.143	.921	1.049	1.143	1.233	.984	.889	1.067	1.031	1.007	1.061
7	.983	.948	1.281	.851	1.250	.865	.851	1.058	1.009	1.049	1.062
8	.999	.957	1.262	1.353	1.164	.479	.862	1.106	.997	.930	1.090
9	.693	1.188	1.119	1.211	1.248	.455	.850	1.407	.977	1.020	1.055
10	.924	1.083	1.102	1.434	1.110	1.000	1.250	1.000	1.019	1.063	1.077
11+	.802	1.231	.985	1.154	1.381	1.000	1.000	1.000	1.036	1.063	.995

FALL SPAWNERS - ALL GEARS

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	1.000	1.463	.673	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2	1.354	.773	.688	.794	1.000	1.591	.878	1.892	1.132	.984	1.000
3	1.401	.922	.840	.859	.967	1.488	.969	1.710	.997	.957	1.001
4	1.329	1.041	.975	.886	1.071	1.081	1.017	1.102	.963	1.004	1.004
5	1.145	1.055	1.024	.841	.950	1.053	.971	1.104	.906	1.002	1.004
6	1.129	1.058	1.060	1.112	1.142	1.018	.992	1.064	.946	1.020	1.010
7	1.057	1.214	.871	1.189	1.310	1.055	.988	1.085	.996	1.016	1.006
8	1.122	1.116	.918	1.200	1.234	1.069	1.002	1.097	1.005	.965	1.008
9	1.060	1.275	.910	.952	1.194	1.077	1.050	1.450	.992	.998	1.010
10	1.170	1.213	.875	1.249	1.108	1.104	1.014	1.137	1.013	.952	1.019
11+	1.110	1.585	.920	1.553	.953	1.084	.962	1.000	.860	.889	1.004

Table 11. REVISED:UPDATED ratios for 4T herring catch-at-age matrices. Only 1985 and 1986 are shown because these were the years discriminant analysis was applied to the matrices for spawning group assignment and were the only years affected by standardizing spawning group assignment using gonad maturity first and then otolith morphology. A * indicates a division by zero.

SPRING SPAWNERS - ALL GEARS

Age	1985	1986
1	.701	1.516
2	1.122	1.096
3	.784	.831
4	.628	1.308
5	.687	.776
6	.504	1.104
7	.302	.661
8	.358	.241
9	.313	.635
10	*	.809
11+	*	.571

FALL SPAWNERS - ALL GEARS

Age	1985	1986
1	.000	.000
2	1.886	3.617
3	1.798	.845
4	2.330	1.015
5	1.380	.853
6	1.476	1.080
7	2.317	.983
8	2.540	1.264
9	1.725	1.124
10	2.241	1.011
11+	*	1.431

Appendix 1. Catch and weight-at-age matrices for each step in the revision process.

A) EDITED 4T herring catch-at-age ('000s) of spring and fall spawners for all gears.

SPRING SPAWNERS - ALL GEARS

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	1062	8754	501	87	5	0	0	142	32	0	2465
2	12276	20209	9232	1291	772	653	298	760	1487	366	5727
3	11018	15462	21382	9183	22809	21155	5821	9906	6428	2610	4266
4	45222	10657	8598	6313	4543	26970	17232	28242	18468	9253	8735
5	3179	39128	5990	1768	889	2181	10242	21687	21050	29853	9812
6	5088	6293	18443	1680	377	500	790	10801	15338	16528	17937
7	1425	4634	7638	3830	280	74	101	5308	5343	13928	11735
8	1124	1899	3552	857	299	48	58	1967	3402	5989	7227
9	261	650	2367	577	101	11	20	590	395	735	2411
10	4465	713	1075	357	82	0	4	0	159	479	182
11+	2581	2539	1159	661	425	0	0	0	333	190	1888

FALL SPAWNERS - ALL GEARS

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0	762	220	0	0	0	0	0	0	0	66
2	1117	3553	3435	451	203	132	41	74	136	63	3984
3	16452	7604	47484	11772	7863	4603	1163	1416	2979	9498	3710
4	22403	37403	18741	33937	17200	24608	25718	6581	36280	39256	23513
5	13236	24654	23329	8885	22222	10592	14870	19817	27089	33131	43355
6	4138	11664	7272	2926	4806	13977	8965	8636	39484	25265	24599
7	5157	2794	5334	1333	2063	2040	6602	3258	21538	41114	22805
8	17158	3022	1615	735	906	1640	1585	1290	8632	19684	20313
9	1743	4938	1896	248	412	509	515	329	3753	10841	11682
10	2031	1057	1374	193	203	135	208	351	549	4752	4256
11+	15220	6115	389	199	190	179	78	0	707	2001	3041

Appendix 1 (continued)

B) EDITED 4T catch-at-age ('000s) for spring and fall spawners caught with fixed gear.

SPRING SPAWNERS - FIXED GEAR

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0	56	0	86	5	0	0	0	0	0	55
2	8	11	312	880	54	66	9	34	445	127	517
3	5395	6274	10695	8443	22066	15813	3496	7603	4759	1579	2441
4	24282	2279	4855	5876	4450	24667	13898	26196	13423	7540	6794
5	1071	18223	2363	1765	883	1868	8474	19580	16730	22549	8575
6	1708	537	10809	1376	374	455	483	9859	10633	10669	12508
7	457	1098	1859	3643	261	49	48	4860	3156	9477	7119
8	405	143	902	472	282	5	33	1692	2642	3528	5156
9	182	88	968	441	100	1	2	360	29	648	1252
10	2158	278	513	172	82	0	4	0	105	438	182
11+	1537	949	789	659	420	0	0	0	280	164	608

FALL SPAWNERS - FIXED GEAR

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0	484	0	0	0	0	0	0	0	0	0
2	48	3	116	355	0	0	0	0	0	15	0
3	2261	477	10155	5935	2745	942	927	318	1629	8332	1397
4	5744	8835	5976	28516	14650	21758	24653	5946	33724	38281	21019
5	3746	4559	6497	8530	19720	10016	13569	18342	22195	30851	40736
6	890	2650	873	2789	4469	13055	8209	8136	33236	19656	21495
7	864	793	1409	1174	1947	1900	6185	2970	17629	36092	14291
8	4856	1180	253	712	836	1601	1516	1156	7182	15252	14678
9	108	1020	313	144	309	494	487	180	3143	9732	7751
10	367	329	348	193	92	108	208	299	536	4546	2750
11+	2368	560	42	199	67	159	76	0	578	1987	1461

Appendix 1 (continued)

C) EDITED 4T herring catch-at-age ('000s) of spring and fall spawners caught with mobile gear.

SPRING SPAWNERS - MOBILE GEAR

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	1062	8698	501	0	0	0	0	142	32	0	2410
2	12268	20199	8920	411	718	587	289	726	1042	239	5210
3	5623	9188	10687	740	743	5341	2325	2303	1669	1030	1825
4	20940	8378	3744	437	93	2303	3334	2046	5046	1712	1941
5	2107	20905	3626	3	6	313	1768	2107	4320	7304	1237
6	3380	5756	7634	304	3	45	307	942	4705	5859	5429
7	968	3536	5779	187	19	25	53	447	2187	4450	4616
8	719	1756	2650	385	17	43	25	275	761	2462	2070
9	78	562	1400	136	1	10	18	230	366	87	1159
10	2307	436	562	184	1	0	0	0	54	41	0
11+	1044	1590	369	2	5	0	0	0	53	26	1280

FALL SPAWNERS - MOBILE GEAR

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0	279	1220	0	0	0	0	0	0	0	66
2	1069	3550	3319	96	203	132	41	74	136	47	3984
3	14191	7128	37329	5836	5117	3662	237	1098	1350	1166	2313
4	16659	28568	12764	5421	2550	2849	1065	636	2555	975	2494
5	9491	20095	16832	355	2501	576	1301	1475	4894	2280	2619
6	3249	9014	6399	137	336	922	756	500	6247	5608	3104
7	4293	2001	3924	159	116	141	418	288	3909	5022	8514
8	12302	1842	1362	23	70	39	69	134	1450	4432	5635
9	1635	3918	1583	104	103	15	28	149	610	1109	3932
10	1665	728	1027	1	111	26	0	53	14	206	1506
11+	12852	5555	348	0	123	20	2	0	129	14	1580

Appendix 1 (continued)

D) EDITED 4T herring mean weight-at-age (kg) of spring and fall spawners caught using all gears.

SPRING SPAWNERS - ALL GEARS

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0779	0.0969	0.1361	0.1137	0.0316	0	0	0.0952	0.1003	0	0.0835
2	0.1313	0.1678	0.1624	0.1567	0.1426	0.1376	0.1488	0.1635	0.1400	0.1919	0.1159
3	0.1697	0.1528	0.1647	0.1831	0.1746	0.1568	0.1836	0.1801	0.2041	0.2226	0.1726
4	0.2238	0.1650	0.1902	0.2334	0.2080	0.2093	0.2004	0.2409	0.2217	0.2157	0.2266
5	0.2471	0.2442	0.2395	0.2656	0.2604	0.2408	0.2192	0.2642	0.2735	0.2614	0.2447
6	0.2810	0.2332	0.2698	0.3236	0.3155	0.2734	0.3031	0.3189	0.2847	0.2981	0.2858
7	0.3072	0.2816	0.2615	0.3314	0.381	0.3287	0.3723	0.3652	0.3467	0.3094	0.3072
8	0.3377	0.2977	0.2804	0.3146	0.3702	0.2528	0.3989	0.4042	0.3788	0.3269	0.3224
9	0.3295	0.3229	0.3221	0.3499	0.396	0.426	0.3375	0.4288	0.3096	0.3417	0.3621
10	0.3505	0.3266	0.3615	0.3386	0.3933	0	0.384	0	0.3948	0.3508	0.401
11+	0.3752	0.3848	0.3952	0.3984	0.4435	0	0	0	0.407	0.4402	0.3915

FALL SPAWNERS - ALL GEARS

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0	0.0385	0.0318	0	0	0	0	0	0	0	0.0726
2	0.098	0.1143	0.1022	0.1289	0.0949	0.1073	0.1047	0.0962	0.1004	0.1408	0.0934
3	0.1458	0.1272	0.1659	0.1924	0.1828	0.175	0.2205	0.1896	0.1812	0.2387	0.198
4	0.223	0.1968	0.2058	0.2423	0.246	0.2457	0.2457	0.2453	0.2359	0.252	0.2611
5	0.264	0.2351	0.2678	0.2884	0.2704	0.2823	0.2817	0.2896	0.2604	0.2816	0.2911
6	0.2801	0.2693	0.2906	0.3536	0.3124	0.3139	0.3187	0.3369	0.3113	0.3132	0.3248
7	0.2949	0.3095	0.3013	0.3851	0.3626	0.347	0.3446	0.3591	0.3531	0.3397	0.3407
8	0.3353	0.3499	0.3157	0.4111	0.3665	0.3647	0.3917	0.3826	0.371	0.3615	0.3681
9	0.3172	0.364	0.3284	0.3686	0.352	0.3704	0.4082	0.4156	0.3913	0.3737	0.3931
10	0.3192	0.3844	0.3683	0.4765	0.3375	0.416	0.3904	0.4459	0.4039	0.38	0.4019
11+	0.3854	0.393	0.4068	0.3957	0.4217	0.4314	0.4861	0.5536	0.3993	0.4108	0.4301

Appendix 1 (continued)

E) EDITED 4T herring mean weight-at-age (kg) of spring and fall spawners caught with fixed gear.

SPRING SPAWNERS - FIXED GEAR

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0	0.0194	0	0.1137	0.0316	0	0	0	0	0	0.039
2	0.0798	0.1147	0.2232	0.1527	0.1841	0.1376	0.113	0.2314	0.176	0.0868	0.083
3	0.15	0.1678	0.1617	0.1814	0.1733	0.1468	0.1692	0.1717	0.2032	0.2004	0.1647
4	0.1858	0.1998	0.1823	0.2315	0.2076	0.2078	0.1941	0.24	0.2123	0.188	0.2169
5	0.2133	0.2322	0.2365	0.2656	0.2603	0.2363	0.2128	0.2621	0.2739	0.2174	0.2406
6	0.2585	0.2299	0.272	0.3121	0.3154	0.2675	0.307	0.319	0.2781	0.2463	0.2634
7	0.2908	0.3034	0.3061	0.3337	0.3748	0.3358	0.3962	0.3666	0.3567	0.2662	0.2852
8	0.3037	0.3451	0.3348	0.348	0.3733	0.2528	0.4462	0.4009	0.3853	0.2736	0.2983
9	0.3271	0.345	0.3661	0.3711	0.3958	0.426	0.3903	0.4168	0.3495	0.2979	0.3343
10	0.3258	0.3148	0.3751	0.3909	0.3931	0	0.384	0	0.3821	0.3046	0.401
11+	0.3593	0.3482	0.3849	0.3984	0.4435	0	0	0	0.4134	0.4002	0.3169

FALL SPAWNERS - FIXED GEAR

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0	0.0231	0	0	0	0	0	0	0	0	
2	0.0808	0.1003	0.1922	0.1331	0	0	0	0	0	0.1405	0
3	0.1414	0.2033	0.207	0.2095	0.2094	0.1857	0.2354	0.2023	0.1975	0.2401	0.2454
4	0.2447	0.256	0.2523	0.2462	0.2526	0.2492	0.247	0.2483	0.2368	0.2518	0.265
5	0.2872	0.2972	0.3052	0.29	0.2719	0.2841	0.2849	0.2919	0.2619	0.2812	0.2923
6	0.3144	0.3271	0.3453	0.3569	0.3151	0.3158	0.3228	0.3393	0.3165	0.3184	0.3251
7	0.3232	0.3612	0.3513	0.39	0.3622	0.3493	0.3473	0.366	0.3628	0.3418	0.3519
8	0.3676	0.3999	0.3734	0.4167	0.3687	0.3648	0.3951	0.3875	0.3808	0.3671	0.3782
9	0.3892	0.4141	0.3928	0.4485	0.368	0.3693	0.4113	0.4196	0.3988	0.3762	0.4024
10	0.3451	0.4311	0.4389	0.4756	0.3495	0.4625	0.3904	0.4425	0.4035	0.3783	0.399
11+	0.4261	0.4169	0.4408	0.3957	0.3873	0.4289	0.4877	0.5536	0.3954	0.4107	0.4509

Appendix 1 (continued)

F) EDITED 4T herring mean weight-at-age (kg) of spring and fall spawners caught with mobile gear.

SPRING SPAWNERS - MOBILE GEAR

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0779	0.0974	0.1361	0.0281	0.0316	0	0	0.0952	0.1003	0	0.0845
2	0.1313	0.1678	0.1603	0.1652	0.1395	0.1376	0.1499	0.1603	0.1246	0.2071	0.1192
3	0.1887	0.1426	0.1677	0.203	0.2135	0.1863	0.2053	0.2077	0.2064	0.2319	0.1831
4	0.2678	0.1555	0.2005	0.2599	0.2298	0.2247	0.2269	0.2514	0.2467	0.2491	0.2606
5	0.2642	0.2547	0.2415	0.2604	0.274	0.2672	0.2497	0.2833	0.2723	0.2986	0.2732
6	0.2923	0.2335	0.2666	0.3757	0.3208	0.3331	0.297	0.3175	0.2997	0.3239	0.3376
7	0.3149	0.2748	0.2471	0.2867	0.465	0.3146	0.3509	0.35	0.3323	0.3346	0.3412
8	0.3568	0.2938	0.262	0.2736	0.3198	0.2528	0.3364	0.4243	0.3563	0.3478	0.3823
9	0.3352	0.3195	0.2917	0.2809	0.4132	0.426	0.3324	0.4476	0.3064	0.4309	0.3923
10	0.3736	0.3342	0.349	0.2898	0.4322	0	0	0	0.4194	0.4854	0.3394
11+	0.3988	0.4066	0.4173	0.3966	0.4456	0	0	0	0.374	0.5093	0.427

FALL SPAWNERS - MOBILE GEAR

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0	0.0652	0.0318	0	0	0	0	0	0	0	0.0726
2	0.0987	0.1143	0.0990	0.1135	0.0949	0.1073	0.1047	0.0962	0.1004	0.1409	0.0934
3	0.1465	0.1221	0.1547	0.1751	0.1685	0.1722	0.162	0.1859	0.1615	0.2289	0.1694
4	0.2155	0.1785	0.1840	0.2218	0.2082	0.219	0.217	0.218	0.2245	0.2593	0.2278
5	0.2548	0.221	0.2533	0.2512	0.2584	0.2513	0.2485	0.2607	0.2539	0.2875	0.2725
6	0.2707	0.2523	0.2831	0.2862	0.2775	0.288	0.2736	0.2984	0.2839	0.2953	0.3223
7	0.2891	0.289	0.2834	0.349	0.3684	0.3161	0.3054	0.2884	0.3093	0.3243	0.3219
8	0.3226	0.3178	0.3050	0.2365	0.3407	0.3618	0.3163	0.3411	0.3224	0.3423	0.3418
9	0.3125	0.3509	0.3157	0.2583	0.3043	0.4101	0.3558	0.4108	0.3525	0.3518	0.3748
10	0.3135	0.3633	0.3444	0.6919	0.3275	0.2231	0	0.4648	0.4198	0.4182	0.4072
11+	0.3779	0.3906	0.4027	0	0.4404	0.4518	0.4143	0	0.417	0.417	0.4109

G) UPDATED 4T herring catch-at-age ('000s) of spring and fall spawners caught in all gears.

SPRING SPAWNERS - ALL GEARS

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	107	0	35	1131	1434	6787	701	85	7	0	0	271	31	0	2467
2	2616	1058	16335	3541	16542	15870	12366	1674	772	305	237	1414	1496	306	5697
3	4932	20105	6679	58151	13469	14435	24371	12588	24424	16343	5366	11196	6473	2360	5797
4	4081	10670	36486	8676	52354	10846	11445	8131	4339	26786	16610	30506	18870	9357	10883
5	1978	2053	5117	8359	3736	37186	6957	2044	1063	2017	9884	24126	21619	29599	11132
6	22693	11944	1528	888	5814	5795	19340	1921	465	492	702	11527	15812	16648	19027
7	7646	21774	204	2569	1401	4393	9782	3258	350	64	86	5615	5389	14614	12458
8	4209	3082	7439	315	1123	1817	4482	1160	348	23	50	2175	3393	5572	7878
9	4968	3314	860	3584	181	772	2649	699	126	5	17	830	386	750	2544
10	605	4802	480	3873	4125	772	1185	512	91	0	5	0	162	509	196
11+	5363	5837	3736	3459	2070	3125	1142	763	587	0	0	0	345	202	1878

FALL SPAWNERS - ALL GEARS

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	101	0	0	0	0	1115	148	0	0	0	0	0	0	0	66
2	2421	23	71	195	1512	2747	2364	358	203	210	36	140	154	62	3984
3	4478	4149	164	6995	23044	7010	39878	10107	7606	6850	1127	2421	2971	9090	3714
4	26000	5110	1976	10091	29774	38935	18275	30067	18424	26606	26157	7254	34953	39403	23612
5	9632	30464	5872	19178	15160	26002	23878	7476	21118	11157	14436	21873	24556	33195	43538
6	5032	8896	17483	8318	4672	12342	7705	3255	5488	14225	8892	9191	37362	25761	24846
7	18672	4122	4491	14338	5452	3392	4648	1585	2703	2152	6526	3534	21459	41792	22950
8	974	7228	3022	6408	19244	3374	1482	882	1118	1753	1588	1415	8679	18992	20477
9	4621	3049	5327	2484	1847	6294	1726	236	492	548	541	477	3724	10713	11800
10	3082	4490	1181	4884	2377	1282	1202	241	225	149	211	399	556	4526	4338
11+	8962	19984	33949	19963	16893	9695	358	309	181	194	75	0	608	1778	3054

H) UPDATED 4T herring catch-at-age ('000s) for spring and fall spawners caught with fixed gear.

SPRING SPAWNERS - FIXED GEAR

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	1	0	0	17	0	105	0	85	7	0	0	0	0	0	57
2	107	51	0	40	4	17	205	947	52	73	11	32	446	150	487
3	3454	14335	1410	18158	5544	5974	11194	11285	23679	14226	3549	6808	4827	1325	3972
4	3160	3189	16902	2901	25449	2292	7078	7363	4246	25857	14001	26607	13982	7695	8942
5	1352	926	2610	4121	1142	17595	2693	2041	1057	1892	8501	20110	17443	22395	9895
6	15869	1737	528	489	1631	552	9204	1385	461	474	462	9732	11263	10559	13598
7	2674	6581	114	90	227	1214	1869	2929	331	54	44	4763	3276	9722	7842
8	2952	1360	3737	117	257	180	892	480	331	5	31	1650	2657	3504	5807
9	2951	1043	505	1082	88	131	764	459	125	1	2	393	32	681	1385
10	332	1497	300	22	1379	303	456	187	91	0	5	0	110	441	196
11+	541	1211	2632	803	764	1266	683	761	583	0	0	0	283	169	598

FALL SPAWNERS - FIXED GEAR

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0	0	0	0	0	903	0	0	0	0	0	0	0	0	0
2	0	0	0	0	80	6	91	281	0	0	0	0	0	15	0
3	157	0	8	434	3520	532	8149	5406	2492	993	920	328	1551	8166	1401
4	5577	1437	344	3164	5608	10754	5460	25698	15876	22006	25228	6043	32442	38450	21118
5	1764	6601	1845	480	3593	5789	6285	7187	18618	10225	13303	19063	19824	30658	40919
6	534	968	5052	384	904	2672	1023	3142	5152	12739	8235	8238	31320	20148	21742
7	2125	634	625	4013	958	907	1244	1457	2586	1927	6162	2985	17678	36671	14437
8	145	605	221	222	5103	1068	269	863	1048	1690	1529	1160	7277	14711	14841
9	1635	435	573	92	117	958	293	152	389	524	517	193	3135	9517	7868
10	383	475	72	664	521	265	302	240	114	108	211	299	543	4340	2832
11+	2582	1671	2500	1000	2589	710	52	309	58	162	74	0	484	1764	1475

Appendix 1 (continued)

I) UPDATED 4T herring catch-at-age ('000s) of spring and fall spawners caught with mobile gear.

SPRING SPAWNERS - MOBILE GEAR

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	106	0	35	1114	1434	6681	701	0	0	0	0	271	31	0	2410
2	2508	1007	16335	3501	16538	15853	12161	727	720	232	226	1382	1050	155	5210
3	1478	5771	5269	39993	7925	8461	13177	1303	745	2117	1818	4388	1647	1035	1825
4	921	7481	19584	5775	26905	8555	4366	768	93	928	2609	3900	4888	1659	1941
5	627	1127	2507	4238	2594	19591	4265	3	6	125	1383	4016	4177	7204	1237
6	6824	10207	1000	400	4184	5243	10136	536	3	18	240	1795	4549	6089	5429
7	4971	15193	90	2479	1174	3179	7913	329	19	10	42	852	2114	4892	4616
8	1257	1722	3702	199	866	1637	3590	679	17	17	19	524	736	2068	2070
9	2017	2271	355	2501	93	641	1885	239	1	4	14	438	354	69	1159
10	273	3305	179	3851	2746	469	729	326	1	0	0	0	52	68	0
11+	4822	4625	1104	2656	1306	1859	459	2	5	0	0	0	52	32	1280

FALL SPAWNERS - MOBILE GEAR

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	101	0	0	0	0	212	148	0	0	0	0	0	0	0	66
2	2421	23	71	195	1432	2741	2273	77	203	210	36	140	154	47	3984
3	4320	4149	155	6561	19524	6478	31729	4702	5114	5857	207	2092	1420	924	2313
4	20423	3673	1632	6927	24166	28182	12815	4369	2548	4600	929	1211	2511	954	2494
5	7868	23863	4027	18698	11567	20212	17593	289	2500	933	1133	2810	4732	2537	2619
6	4498	7928	12431	7934	3767	9670	6682	112	336	1486	657	952	6042	5613	3104
7	16547	3488	3866	10325	4494	2485	3404	129	116	225	364	549	3781	5121	8514
8	829	6623	2801	6185	14142	2306	1213	19	70	62	60	255	1401	4281	5635
9	2985	2614	4754	2392	1730	5336	1433	84	103	23	25	284	590	1197	3932
10	2699	4015	1110	4220	1856	1017	900	1	111	42	0	100	13	186	1506
11+	6380	18314	31449	18963	14305	8986	305	0	123	32	1	0	124	13	1580

J) UPDATED 4T herring mean weight-at-age (kg) of all spring and fall spawners caught with all gear.

SPRING SPAWNERS - ALL GEARS

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0537	0	0.064	0.101	0.0779	0.0953	0.1361	0.1128	0.0316	0	0	0.0952	0.1003	0	0.0834
2	0.125	0.086	0.1405	0.1401	0.1307	0.1654	0.1629	0.1573	0.142	0.1376	0.1481	0.1619	0.1402	0.1408	0.116
3	0.1606	0.1526	0.1626	0.1832	0.1704	0.1483	0.1658	0.1834	0.1747	0.1556	0.1809	0.1873	0.2031	0.1982	0.1716
4	0.2084	0.1742	0.1888	0.1965	0.2268	0.1665	0.1852	0.2338	0.2077	0.2099	0.1991	0.2405	0.2205	0.1990	0.2168
5	0.2299	0.2091	0.2108	0.2347	0.245	0.243	0.2342	0.2636	0.2624	0.2386	0.2179	0.2641	0.2718	0.2348	0.2401
6	0.2537	0.2026	0.2301	0.2638	0.2789	0.2349	0.2662	0.3288	0.3175	0.2738	0.3011	0.318	0.2834	0.2748	0.2837
7	0.2818	0.2547	0.2674	0.2847	0.3103	0.2859	0.2555	0.326	0.3816	0.3326	0.373	0.3635	0.3454	0.2928	0.3058
8	0.2864	0.2937	0.2963	0.2786	0.3439	0.3018	0.2728	0.3016	0.3801	0.2528	0.4025	0.4056	0.3785	0.3052	0.3209
9	0.2963	0.3212	0.3169	0.311	0.3311	0.3231	0.3095	0.3411	0.4028	0.426	0.3401	0.4321	0.3098	0.3158	0.3609
10	0.3077	0.3176	0.3185	0.3238	0.3563	0.328	0.3546	0.3279	0.4058	0	0.3818	0	0.3915	0.3287	0.3959
11+	0.3429	0.3623	0.3189	0.3468	0.3876	0.3793	0.394	0.3973	0.4445	0	0	0	0.4026	0.4163	0.3922

FALL SPAWNERS - ALL GEARS

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0498	0	0	0	0	0.0311	0.0318	0	0	0	0	0	0	0	0.0726
2	0.0665	0.0566	0.0887	0.1178	0.0972	0.1128	0.1023	0.1284	0.0949	0.1073	0.1047	0.0962	0.1023	0.1408	0.0934
3	0.1352	0.1103	0.1802	0.138	0.1458	0.1218	0.1596	0.1931	0.1819	0.1742	0.2208	0.1881	0.181	0.2313	0.1981
4	0.1968	0.2	0.1866	0.214	0.2208	0.1984	0.2036	0.2425	0.2486	0.2439	0.2455	0.2449	0.2374	0.2469	0.2608
5	0.2333	0.2388	0.2219	0.2249	0.2634	0.2368	0.2676	0.3065	0.2729	0.2816	0.2824	0.2875	0.2646	0.2810	0.2909
6	0.2637	0.2662	0.2722	0.2583	0.2793	0.2697	0.2921	0.3601	0.3175	0.3126	0.3182	0.3341	0.3141	0.3145	0.3244
7	0.2629	0.2994	0.2875	0.2974	0.2949	0.3095	0.309	0.3873	0.3659	0.3453	0.3443	0.354	0.3536	0.3414	0.3404
8	0.316	0.3028	0.3192	0.2995	0.3351	0.3426	0.3281	0.4054	0.3677	0.3636	0.3924	0.3784	0.3708	0.3663	0.3676
9	0.314	0.3269	0.328	0.3203	0.3173	0.355	0.3455	0.3809	0.3594	0.3701	0.4079	0.4135	0.3922	0.3793	0.3925
10	0.3071	0.3337	0.3551	0.328	0.3194	0.3673	0.3836	0.472	0.3386	0.3929	0.3918	0.4472	0.4036	0.3889	0.4008
11+	0.352	0.3653	0.3812	0.3545	0.386	0.3824	0.4155	0.4246	0.4236	0.4311	0.4869	0.5536	0.4148	0.4305	0.43

K) UPDATED 4T herring mean weight-at-age (kg) of spring and fall spawners caught with fixed gear.

SPRING SPAWNERS - FIXED GEAR

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0537	0	0	0.101	0	0.0194	0	0.1128	0.0316	0	0	0	0	0	0.0386
2	0.1129	0.1146	0	0.16	0.0798	0.1171	0.2265	0.1511	0.1762	0.1376	0.1123	0.2329	0.1759	0.0906	0.0818
3	0.1573	0.1536	0.1594	0.1562	0.149	0.1673	0.1573	0.1812	0.1735	0.151	0.1684	0.1741	0.2023	0.1752	0.1663
4	0.2057	0.1941	0.1854	0.1882	0.1852	0.1997	0.1719	0.231	0.2072	0.2093	0.1939	0.2389	0.2114	0.1883	0.2073
5	0.2254	0.2292	0.2177	0.2217	0.2038	0.2319	0.2182	0.2636	0.2623	0.2367	0.2128	0.2603	0.2716	0.2159	0.236
6	0.2507	0.2493	0.2488	0.2611	0.2449	0.235	0.2664	0.3106	0.3175	0.2716	0.3032	0.3181	0.2768	0.2463	0.2622
7	0.2735	0.2773	0.2587	0.2629	0.2912	0.3047	0.2933	0.3304	0.3768	0.3358	0.3937	0.3659	0.3539	0.2703	0.2849
8	0.2849	0.2893	0.2868	0.274	0.299	0.3404	0.3268	0.3412	0.3833	0.2528	0.4444	0.3996	0.3847	0.2744	0.299
9	0.2937	0.3022	0.3087	0.2969	0.3271	0.345	0.3653	0.3725	0.4027	0.426	0.3903	0.4149	0.3466	0.3028	0.3347
10	0.3043	0.3115	0.2965	0.2998	0.3199	0.318	0.3723	0.3946	0.4057	0	0.3819	0	0.3783	0.3060	0.3959
11+	0.3281	0.3383	0.3115	0.3239	0.3614	0.3507	0.3845	0.3973	0.4445	0	0	0	0.4076	0.3991	0.3177

FALL SPAWNERS - FIXED GEAR

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0	0	0	0	0	0.0231	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0.0808	0.1003	0.1922	0.1325	0	0	0	0	0	0.1405	0
3	0.1669	0	0.2134	0.1705	0.1378	0.2027	0.2072	0.2087	0.2094	0.1863	0.234	0.202	0.2	0.2345	0.2454
4	0.2227	0.2383	0.2609	0.2375	0.2373	0.2547	0.2565	0.246	0.255	0.2492	0.2466	0.2503	0.2385	0.2469	0.2647
5	0.2696	0.2772	0.2898	0.2791	0.2825	0.2945	0.3113	0.3087	0.2748	0.2844	0.2852	0.2914	0.2671	0.2805	0.2921
6	0.2972	0.3155	0.3142	0.2873	0.306	0.3239	0.3597	0.3627	0.3201	0.3156	0.3217	0.3383	0.3199	0.3192	0.3247
7	0.3089	0.3341	0.3429	0.3222	0.3153	0.3583	0.3575	0.3906	0.3658	0.3488	0.3466	0.366	0.3631	0.3439	0.3512
8	0.3363	0.3436	0.3489	0.3375	0.3642	0.3992	0.3857	0.409	0.3694	0.3637	0.3953	0.3866	0.3801	0.3729	0.3774
9	0.3501	0.3732	0.3775	0.3598	0.3734	0.4143	0.4082	0.4482	0.374	0.3683	0.4104	0.4175	0.3997	0.3814	0.4013
10	0.3381	0.3783	0.3604	0.3699	0.3382	0.4288	0.4474	0.4712	0.3495	0.4588	0.3918	0.4413	0.4032	0.3878	0.3973
11+	0.3753	0.4007	0.4074	0.3927	0.4195	0.4201	0.4677	0.4246	0.388	0.427	0.4884	0.5536	0.4142	0.4306	0.4504

Appendix 1 (continued)

L) UPDATED 4T herring mean weight-at-age (kg) of spring and fall spawners caught with mobile gear.

SPRING SPAWNERS - MOBILE GEAR

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0537	0	0.064	0.101	0.0779	0.0965	0.1361	0.0281	0.0316	0	0	0.0952	0.1003	0	0.0845
2	0.1255	0.0846	0.1405	0.1399	0.1307	0.1654	0.1618	0.1652	0.1395	0.1376	0.1499	0.1603	0.125	0.1893	0.1192
3	0.1683	0.1499	0.1634	0.1955	0.1853	0.1348	0.173	0.2031	0.2135	0.1862	0.2053	0.2077	0.2055	0.2276	0.1831
4	0.2178	0.1657	0.1917	0.2006	0.2661	0.1576	0.2066	0.2602	0.2298	0.2245	0.2269	0.2514	0.2466	0.2486	0.2606
5	0.2396	0.1927	0.2036	0.2474	0.2632	0.253	0.2443	0.2604	0.274	0.2669	0.2497	0.2833	0.2723	0.2934	0.2732
6	0.2605	0.1947	0.2203	0.2672	0.2921	0.2349	0.266	0.3759	0.3208	0.3322	0.297	0.3175	0.2997	0.3242	0.3376
7	0.2862	0.2449	0.2784	0.2854	0.314	0.2787	0.2466	0.2863	0.465	0.3147	0.3509	0.35	0.3323	0.3376	0.3412
8	0.2901	0.2972	0.3059	0.2814	0.3572	0.2975	0.2594	0.2736	0.3198	0.2528	0.3364	0.4243	0.3562	0.3574	0.3623
9	0.3	0.3298	0.3285	0.3171	0.3349	0.3187	0.2868	0.2807	0.4132	0.426	0.3324	0.4476	0.3064	0.4454	0.3923
10	0.3119	0.3203	0.3553	0.324	0.3745	0.3344	0.3435	0.2897	0.4322	0	0.3515	0	0.4194	0.4769	0.3394
11+	0.3445	0.3686	0.3365	0.3537	0.4029	0.3987	0.4081	0.3966	0.4456	0	0	0	0.374	0.5062	0.427

FALL SPAWNERS - MOBILE GEAR

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0498	0	0	0	0	0.0652	0.0318	0	0	0	0	0	0	0	0.0726
2	0.0665	0.0566	0.0887	0.1178	0.0981	0.1129	0.0987	0.1133	0.0949	0.1073	0.1047	0.0962	0.1023	0.1409	0.0934
3	0.134	0.1103	0.1784	0.1358	0.1473	0.1152	0.1473	0.1751	0.1685	0.1722	0.1617	0.1859	0.1602	0.2032	0.1694
4	0.1897	0.185	0.1709	0.2033	0.217	0.177	0.181	0.2218	0.2082	0.2186	0.2168	0.218	0.2236	0.2493	0.2278
5	0.2252	0.2281	0.1908	0.2235	0.2575	0.2202	0.252	0.2516	0.2584	0.2507	0.2484	0.2607	0.2539	0.2869	0.2725
6	0.2597	0.2602	0.2551	0.2569	0.273	0.2547	0.2818	0.2872	0.2775	0.2875	0.2736	0.2984	0.2839	0.2974	0.3223
7	0.257	0.2931	0.2786	0.2878	0.2905	0.2918	0.2913	0.3497	0.3684	0.3161	0.3053	0.2884	0.3093	0.3238	0.3219
8	0.3125	0.299	0.3169	0.2981	0.3246	0.3163	0.3153	0.2383	0.3407	0.3618	0.3163	0.3411	0.3224	0.3436	0.3418
9	0.2942	0.3192	0.322	0.3188	0.3135	0.3444	0.3326	0.2583	0.3043	0.4101	0.3558	0.4108	0.3525	0.3623	0.3748
10	0.3027	0.3284	0.3548	0.3214	0.3141	0.3513	0.3622	0.6919	0.3275	0.2231	0	0.4648	0.4198	0.4143	0.4072
11+	0.3426	0.362	0.3791	0.3525	0.3799	0.3794	0.4065	0	0.4404	0.4518	0.4143	0	0.417	0.417	0.4109

M) REVISED 4T herring catch-at-age ('000s) of spring and fall spawners caught with all gears.

ALL GEARS - SPRING SPAWNERS

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	107	0	35	1131	1434	6787	701	85	7	0	0	190	47	0	2467
2	2616	1058	16335	3541	16542	15870	12366	1674	772	305	237	1587	1639	306	5697
3	4932	20105	6679	58151	13469	14435	24371	12588	24424	16343	5366	8782	5379	2360	5797
4	4081	10670	36486	8676	52354	10846	11445	8131	4339	26786	16610	19159	24684	8357	10883
5	1978	2053	5117	8359	3736	37186	6957	2044	1063	2017	9884	16581	16783	29599	11132
6	22693	11944	1528	888	5814	5795	19340	1921	465	492	702	5804	17456	16648	19027
7	7646	21774	204	2569	1401	4393	9782	3258	350	64	86	1693	3561	14614	12458
8	4209	3082	7439	315	1123	1817	4482	1160	348	23	50	779	818	5572	7878
9	4968	3314	860	3584	181	772	2649	699	126	5	17	260	245	750	2544
10	605	4802	480	3873	4125	772	1185	512	91	0	5	4	131	509	196
11+	5363	5837	3736	3459	2070	3125	1142	763	587	0	0	155	197	202	1878

ALL GEARS - FALL SPAWNERS

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	101	0	0	0	0	1115	148	0	0	0	0	0	0	0	66
2	2421	23	71	195	1512	2747	2364	358	203	210	36	264	557	62	3984
3	4478	4149	164	6995	23044	7010	39878	10107	7606	6850	1127	4353	2510	9090	3714
4	26000	5110	1976	10091	29774	38935	18275	30067	18424	26606	26157	16904	35492	39403	23612
5	9632	30464	5872	19178	15160	26002	23878	7476	21118	11157	14436	30191	20940	33195	43538
6	5032	8896	17483	8318	4672	12342	7705	3255	5488	14225	8892	13562	40368	25761	24846
7	18672	4122	4491	14338	5452	3392	4648	1585	2703	2152	6526	8188	21094	41792	22950
8	974	7228	3022	6408	19244	3374	1482	882	1118	1753	1588	3594	10967	18992	20477
9	4621	3049	5327	2484	1847	6294	1726	236	492	548	541	823	4185	10713	11800
10	3082	4490	1181	4884	2377	1282	1202	241	225	149	211	894	562	4526	4338
11+	8962	19984	33949	19963	16893	9695	358	309	181	194	75	295	870	1778	3054

N) REVISED 4T herring catch-at-age ('000s) for spring and fall spawners caught with fixed gear.

FIXED GEAR - SPRING SPAWNERS

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	1	0	0	17	0	105	0	85	7	0	0	0	0	0	57
2	107	51	0	40	4	17	205	947	52	73	11	360	50	150	487
3	3454	14335	1410	18158	5544	5974	11194	11285	23679	14226	3549	6085	3026	1325	3972
4	3160	3189	16902	2901	25449	2292	7078	7363	4246	25857	14001	16610	17926	7697	8942
5	1352	926	2610	4121	1142	17595	2693	2041	1057	1892	8501	15127	11485	22395	9895
6	15869	1737	528	489	1631	552	9204	1385	461	474	462	5145	11994	10559	13598
7	2674	6581	114	90	227	1214	1869	2929	331	54	44	1418	1675	9722	7842
8	2952	1360	3737	117	257	180	892	480	331	5	31	643	383	3504	5807
9	2951	1043	505	1082	88	131	764	459	125	1	2	75	24	681	1385
10	332	1497	300	22	1379	303	456	187	91	0	5	4	117	441	196
11+	541	1211	2632	803	764	1266	683	761	583	0	0	9	137	169	598

FIXED GEAR - FALL SPAWNERS

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0	0	0	0	0	903	0	0	0	0	0	0	0	0	0
2	0	0	0	0	80	6	91	281	0	0	0	31	403	15	0
3	157	0	8	434	3520	532	8149	5406	2492	993	920	1966	1606	8166	1401
4	5577	1437	344	3164	5608	10754	5460	25698	15876	22006	25228	14054	33820	38450	21118
5	1764	6601	1845	480	3593	5789	6285	7187	18618	10225	13303	25547	17678	30658	40919
6	534	968	5052	384	904	2672	1023	3142	5152	12739	8235	10342	35098	20148	21742
7	2125	634	625	4013	958	907	1244	1457	2586	1927	6162	6622	18454	36671	14437
8	145	605	221	222	5103	1068	269	863	1048	1690	1529	2829	9483	14711	14841
9	1635	435	573	92	117	958	293	152	389	524	517	541	3402	9517	7868
10	383	475	72	664	521	265	302	240	114	108	211	481	362	4340	2832
11+	2582	1671	2500	1000	2589	710	52	309	58	162	74	27	745	1764	1475

O) REVISED 4T herring catch-at-age ('000s) for spring and fall spawners caught with mobile gear.

MOBILE GEAR - SPRING SPAWNERS

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	106	0	35	1114	1434	6681	701	0	0	0	0	190	47	0	2410
2	2508	1007	16335	3501	16538	15853	12161	727	720	232	226	1227	1589	155	5210
3	1478	5771	5269	39993	7925	8461	13177	1303	745	2117	1818	2697	2353	1035	1825
4	921	7481	19584	5775	26905	8555	4366	768	93	928	2609	2549	6758	1659	1941
5	627	1127	2507	4238	2594	19591	4265	3	6	125	1383	1454	5298	7204	1237
6	6824	10207	1000	400	4184	5243	10136	536	3	18	240	659	5463	6089	5429
7	4971	15193	90	2479	1174	3179	7913	329	19	10	42	275	1886	4892	4616
8	1257	1722	3702	199	866	1637	3590	679	17	17	19	136	435	2068	2070
9	2017	2271	355	2501	93	641	1885	239	1	4	14	185	220	69	1159
10	273	3305	179	3851	2746	469	729	326	1	0	0	0	14	68	0
11+	4822	4625	1104	2656	1306	1859	459	2	5	0	0	146	59	32	1280

MOBILE GEAR - FALL SPAWNERS

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	101	0	0	0	0	212	148	0	0	0	0	0	0	0	66
2	2421	23	71	195	1432	2741	2273	77	203	210	36	233	154	47	3984
3	4320	4149	155	6561	19524	6478	31729	4702	5114	5857	207	2387	903	924	2313
4	20423	3673	1632	6927	24166	28182	12815	4369	2548	4600	929	2850	1672	954	2494
5	7868	23863	4027	18698	11567	20212	17593	289	2500	933	1133	4644	3262	2537	2619
6	4498	7928	12431	7934	3767	9670	6682	112	336	1486	657	3220	5271	5613	3104
7	16547	3488	3866	10325	4494	2485	3404	129	116	225	364	1566	2640	5121	8514
8	829	6623	2801	6185	14142	2306	1213	19	70	62	60	765	1485	4281	5635
9	2985	2614	4754	2392	1730	5336	1433	84	103	23	25	282	783	1197	3932
10	2699	4015	1110	4220	1856	1017	900	1	111	42	0	413	200	186	1506
11+	6380	18314	31449	18963	14305	8986	305	0	123	32	1	268	125	13	1580

P) REVISED 4T herring mean weight-at-age (kg) of spring and fall spawners caught caught with all gears.

ALL GEARS - SPRING SPAWNERS

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0537	0	0.064	0.101	0.0779	0.0953	0.1361	0.1128	0.0316	0	0	0.0872	0.089	0	0.0834
2	0.125	0.086	0.1405	0.1401	0.1307	0.1654	0.1629	0.1573	0.142	0.1376	0.1481	0.1702	0.1404	0.1408	0.116
3	0.1606	0.1526	0.1626	0.1832	0.1704	0.1483	0.1658	0.1834	0.1747	0.1556	0.1809	0.1886	0.1796	0.1982	0.1716
4	0.2084	0.1742	0.1886	0.1965	0.2268	0.1665	0.1852	0.2338	0.2077	0.2099	0.1991	0.2231	0.2137	0.1990	0.2168
5	0.2299	0.2091	0.2108	0.2347	0.245	0.243	0.2342	0.2636	0.2624	0.2386	0.2179	0.2492	0.2498	0.2348	0.2401
6	0.2537	0.2026	0.2301	0.2638	0.2789	0.2349	0.2662	0.3288	0.3175	0.2738	0.3011	0.2803	0.2771	0.2748	0.2837
7	0.2818	0.2547	0.2674	0.2847	0.3103	0.2859	0.2555	0.326	0.3816	0.3326	0.373	0.3379	0.3156	0.2928	0.3058
8	0.2864	0.2937	0.2963	0.2786	0.3439	0.3018	0.2728	0.3016	0.3801	0.2528	0.4025	0.3767	0.3466	0.3052	0.3209
9	0.2963	0.3212	0.3169	0.311	0.3311	0.3231	0.3095	0.3411	0.4028	0.426	0.3401	0.4793	0.3152	0.3158	0.3609
10	0.3077	0.3176	0.3185	0.3238	0.3563	0.328	0.3546	0.3279	0.4058	0	0.3818	0.386	0.3143	0.3287	0.3959
11+	0.3429	0.3623	0.3189	0.3468	0.3876	0.3793	0.394	0.3973	0.4445	0	0	0.3262	0.4046	0.4163	0.3922

ALL GEARS - FALL SPAWNERS

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0498	0	0	0	0	0.0311	0.0318	0	0	0	0	0	0	0	0.0726
2	0.0665	0.0566	0.0887	0.1178	0.0972	0.1128	0.1023	0.1284	0.0949	0.1073	0.1047	0.1176	0.1558	0.1408	0.0934
3	0.1352	0.1103	0.1802	0.138	0.1458	0.1218	0.1596	0.1931	0.1819	0.1742	0.2208	0.2242	0.1845	0.2313	0.1981
4	0.1968	0.2	0.1866	0.214	0.2208	0.1984	0.2036	0.2425	0.2486	0.2439	0.2455	0.2647	0.2476	0.2469	0.2608
5	0.2333	0.2388	0.2219	0.2249	0.2634	0.2368	0.2676	0.3065	0.2729	0.2816	0.2824	0.2928	0.2867	0.2810	0.2909
6	0.2637	0.2662	0.2722	0.2583	0.2793	0.2697	0.2921	0.3601	0.3175	0.3126	0.3182	0.3224	0.3206	0.3145	0.3244
7	0.2629	0.2994	0.2875	0.2974	0.2949	0.3095	0.309	0.3873	0.3659	0.3453	0.3443	0.3548	0.3588	0.3414	0.3404
8	0.316	0.3028	0.3192	0.2995	0.3351	0.3426	0.3281	0.4054	0.3677	0.3636	0.3924	0.3737	0.3759	0.3663	0.3676
9	0.314	0.3269	0.328	0.3203	0.3173	0.355	0.3455	0.3809	0.3594	0.3701	0.4079	0.3972	0.3892	0.3793	0.3925
10	0.3071	0.3337	0.3551	0.328	0.3194	0.3673	0.3836	0.472	0.3386	0.3929	0.3918	0.3938	0.4027	0.3889	0.4008
11+	0.352	0.3653	0.3812	0.3545	0.386	0.3824	0.4155	0.4246	0.4236	0.4311	0.4869	0.4597	0.4138	0.4305	0.43

Q) REVISED 4T herring mean weight-at-age (kg) of spring and fall spawners caught with fixed gear.

FIXED GEAR - SPRING SPAWNERS

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0537	0	0	0.101	0	0.0194	0	0.1128	0.0316	0	0	0	0	0	0.0386
2	0.1129	0.1146	0	0.16	0.0798	0.1171	0.2265	0.1511	0.1762	0.1376	0.1123	0.2193	0.1811	0.0906	0.0818
3	0.1573	0.1536	0.1594	0.1562	0.149	0.1673	0.1573	0.1812	0.1735	0.151	0.1684	0.184	0.1575	0.1752	0.1663
4	0.2057	0.1941	0.1854	0.1882	0.1852	0.1997	0.1719	0.231	0.2072	0.2093	0.1939	0.2209	0.2007	0.1883	0.2073
5	0.2254	0.2292	0.2177	0.2217	0.2038	0.2319	0.2182	0.2636	0.2623	0.2367	0.2128	0.2472	0.2389	0.2159	0.236
6	0.2507	0.2493	0.2488	0.2611	0.2449	0.235	0.2664	0.3106	0.3175	0.2716	0.3032	0.2774	0.2645	0.2463	0.2622
7	0.2735	0.2773	0.2587	0.2629	0.2912	0.3047	0.2933	0.3304	0.3768	0.3358	0.3937	0.3384	0.3001	0.2703	0.2849
8	0.2849	0.2893	0.2868	0.274	0.299	0.3404	0.3268	0.3412	0.3833	0.2528	0.4444	0.3647	0.3448	0.2744	0.299
9	0.2937	0.3022	0.3087	0.2969	0.3271	0.345	0.3653	0.3725	0.4027	0.426	0.3903	0.4283	0.3285	0.3028	0.3347
10	0.3043	0.3115	0.2965	0.2998	0.3199	0.318	0.3723	0.3946	0.4057	0	0.3819	0.386	0.2981	0.3060	0.3959
11+	0.3281	0.3383	0.3115	0.3239	0.3614	0.3507	0.3845	0.3973	0.4445	0	0	0.3414	0.4169	0.3991	0.3177

FIXED GEAR - FALL SPAWNERS

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0	0	0	0	0	0.0231	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0.0808	0.1003	0.1922	0.1325	0	0	0	0.2332	0.1745	0.1405	0
3	0.1669	0	0.2134	0.1705	0.1378	0.2027	0.2072	0.2087	0.2094	0.1863	0.234	0.2629	0.2007	0.2345	0.2454
4	0.2227	0.2383	0.2609	0.2375	0.2373	0.2547	0.2565	0.246	0.255	0.2492	0.2466	0.2733	0.2488	0.2469	0.2647
5	0.2696	0.2772	0.2898	0.2791	0.2825	0.2945	0.3113	0.3087	0.2748	0.2844	0.2852	0.2988	0.292	0.2805	0.2921
6	0.2972	0.3155	0.3142	0.2873	0.306	0.3239	0.3597	0.3627	0.3201	0.3156	0.3217	0.3322	0.3263	0.3192	0.3247
7	0.3089	0.3341	0.3429	0.3222	0.3153	0.3583	0.3575	0.3906	0.3658	0.3488	0.3466	0.364	0.3665	0.3439	0.3512
8	0.3363	0.3436	0.3489	0.3375	0.3642	0.3992	0.3857	0.409	0.3694	0.3637	0.3953	0.3824	0.3849	0.3729	0.3774
9	0.3501	0.3732	0.3775	0.3598	0.3734	0.4143	0.4082	0.4482	0.374	0.3683	0.4104	0.4005	0.4001	0.3814	0.4013
10	0.3381	0.3783	0.3604	0.3699	0.3382	0.4288	0.4474	0.4712	0.3495	0.4588	0.3918	0.383	0.4488	0.3878	0.3973
11+	0.3753	0.4007	0.4074	0.3927	0.4195	0.4201	0.4677	0.4246	0.388	0.427	0.4884	0.4741	0.4157	0.4306	0.4504

R) REVISED 4T herring mean weight-at-age (kg) of spring and fall spawners caught with mobile gear.

MOBILE GEAR - SPRING SPAWNERS

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0537	0	0.064	0.101	0.0779	0.0965	0.1361	0.0281	0.0316	0	0	0.0872	0.089	0	0.0845
2	0.1255	0.0846	0.1405	0.1399	0.1307	0.1654	0.1618	0.1652	0.1395	0.1376	0.1499	0.1558	0.1391	0.1893	0.1192
3	0.1683	0.1499	0.1634	0.1955	0.1853	0.1348	0.173	0.2031	0.2135	0.1862	0.2053	0.199	0.2081	0.2276	0.1831
4	0.2178	0.1657	0.1917	0.2006	0.2661	0.1576	0.2066	0.2602	0.2298	0.2245	0.2269	0.2373	0.2484	0.2486	0.2606
5	0.2396	0.1927	0.2036	0.2474	0.2632	0.253	0.2443	0.2604	0.274	0.2669	0.2497	0.27	0.2735	0.2934	0.2732
6	0.2605	0.1947	0.2203	0.2672	0.2921	0.2349	0.266	0.3759	0.3208	0.3322	0.297	0.3033	0.3049	0.3242	0.3376
7	0.2862	0.2449	0.2784	0.2854	0.314	0.2787	0.2466	0.2863	0.465	0.3147	0.3509	0.3354	0.3293	0.3376	0.3412
8	0.2901	0.2972	0.3059	0.2814	0.3572	0.2975	0.2594	0.2736	0.3198	0.2528	0.3364	0.4335	0.3482	0.3574	0.3823
9	0.3	0.3298	0.3285	0.3171	0.3349	0.3187	0.2868	0.2807	0.4132	0.426	0.3324	0.4999	0.3137	0.4454	0.3923
10	0.3119	0.3203	0.3553	0.324	0.3745	0.3344	0.3435	0.2897	0.4322	0	0.3515	0	0.4544	0.4769	0.3394
11+	0.3445	0.3686	0.3365	0.3537	0.4029	0.3987	0.4081	0.3966	0.4456	0	0	0.3253	0.376	0.5062	0.427

MOBILE GEAR - FALL SPAWNERS

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0498	0	0	0	0	0.0652	0.0318	0	0	0	0	0	0	0	0.0726
2	0.0665	0.0566	0.0887	0.1178	0.0981	0.1129	0.0987	0.1133	0.0949	0.1073	0.1047	0.1024	0.107	0.1409	0.0934
3	0.134	0.1103	0.1784	0.1358	0.1473	0.1152	0.1473	0.1751	0.1685	0.1722	0.1617	0.1923	0.1558	0.2032	0.1694
4	0.1897	0.185	0.1709	0.2033	0.217	0.177	0.181	0.2218	0.2082	0.2186	0.2168	0.222	0.2234	0.2493	0.2278
5	0.2252	0.2281	0.1908	0.2235	0.2575	0.2202	0.252	0.2516	0.2584	0.2507	0.2484	0.2598	0.2575	0.2869	0.2725
6	0.2597	0.2602	0.2551	0.2569	0.273	0.2547	0.2818	0.2872	0.2775	0.2875	0.2736	0.2909	0.2833	0.2974	0.3223
7	0.257	0.2931	0.2786	0.2878	0.2905	0.2918	0.2913	0.3497	0.3684	0.3161	0.3053	0.3157	0.3053	0.3238	0.3219
8	0.3125	0.299	0.3169	0.2981	0.3246	0.3163	0.3153	0.2383	0.3407	0.3618	0.3163	0.3417	0.3188	0.3436	0.3418
9	0.2942	0.3192	0.322	0.3188	0.3135	0.3444	0.3326	0.2583	0.3043	0.4101	0.3558	0.391	0.3417	0.3623	0.3748
10	0.3027	0.3284	0.3548	0.3214	0.3141	0.3513	0.3622	0.6919	0.3275	0.2231	0	0.4064	0.3192	0.4143	0.4072
11+	0.3426	0.362	0.3791	0.3525	0.3799	0.3794	0.4065	0	0.4404	0.4518	0.4143	0.4583	0.403	0.417	0.4109